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FIELD IMPACT EVALUATION REPORT ON THE ELECTRONIC TABULAR DISPLA--ETC(U)
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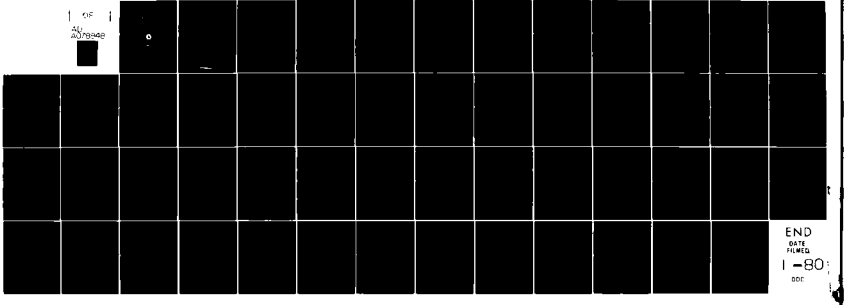

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LEVEL II

FIELD IMPACT EVALUATION REPORT ON THE ELECTRONIC TABULAR DISPLAY SUBSYSTEM (ETABS)

THE ELECTRONIC TABULAR DISPLAY SUBSYSTEM
FIELD IMPACT EVALUATION TEAM

Final Rept.
Nov 78 - July 79.

OCTOBER 1979

Prepared for

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
Systems Research & Development Service
Washington, D.C. 20590

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16. Abstract

A team of field personnel from air traffic and airways facilities conducted an impact assessment of the projected implementation of the Electronic Tabular Display Subsystem (ETABS) at air route traffic control centers. They further developed alternatives which could be expected to reduce or eliminate the negative consequences identified which could result from ETABS implementation. Six impact areas are addressed. These are:

1. Impact on the workforce.
2. Technological considerations.
3. Implementation.
4. Operations.
5. Training.
6. Logistics support.

Conclusions and recommendations as to the most desirable alternative solutions from a field viewpoint are presented.

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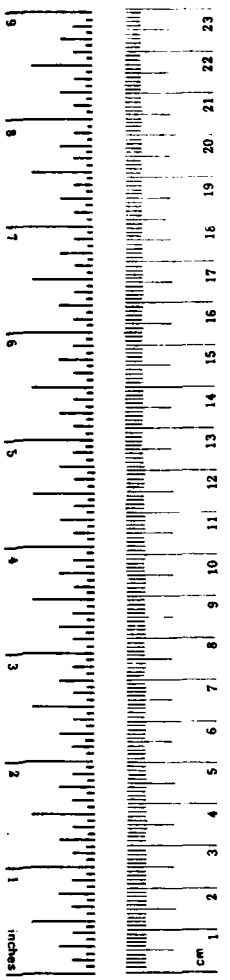
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
	AREA			
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
	MASS (weight)			
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
	VOLUME			
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
	TEMPERATURE (exact)			
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
	AREA			
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
	MASS (weight)			
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
	VOLUME			
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
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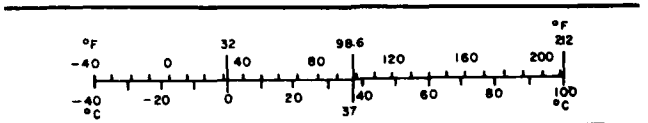
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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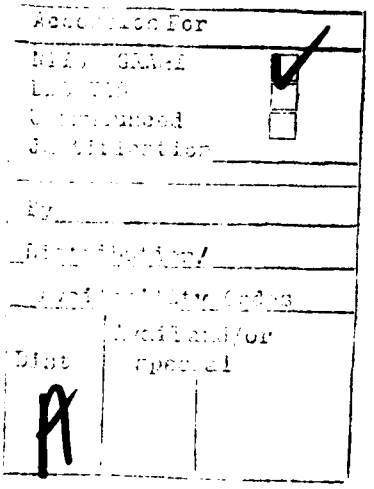


ETABS EVALUATION TEAM

George M. Acri, ARTCC Chief
IND ARTSS
P.O. Box 41070
Indianapolis, Indiana 46241
Home: 317-852-4721
FTS: 317-2230

Ralph Cooper
Seattle ARTCC
3101 Auburn Way South
Auburn, Washington 98002
Home: 206-255-9906
FTS: 396-2540, Ext.295

Brad Cook, AF Sector Manager
Denver ARTCC
2211 17th Avenue
Longmont, Colorado 80501
Home: 305-532-3465
FTS: 323-7361

Leonard A. Crouch
FAA, ASO-430
P.O. Box 20636
Atlanta, Georgia 30320
Home: 996-4437
FTS: 246-7301

Joel DeLuca
56 Hillhouse Avenue
Yale University
New Haven, Conn. 06520
Home: 203-776-4540

Bob Durben
LA ARTCC AFS
2555 E. Avenue
Palmdale, CA 93550
Home: 805-947-0894
FTS: 799-4101

Charles Hulsey
T/S ZKC ARTCC
1801 E. Loula
Olathe, Kansas 66061
Home: 913-682-5771
FTS: 8-752-0253

Bill Koch*
Assistant Chief
Systems Design and
Integration Division
FAA Washington, AEM-301
FTS: 426-8794

Richard Lascola
AFS/ZOB
326 E. Lorain Street
Oberlin, Ohio 44074
Home: 216-365-4050
FTS: 8-292-8150

Gerald Mikuenski
Houston ARTCC
16600 JFK Blvd.
Houston, Texas 77205
Home: 713-681-6311
FTS: 521-3070, Ext. 280

Joseph Sangiuliano
FAA, ARM-530
10455 E. 24th Avenue
Aurora, Colorado 80010
Home: 303-343-9870
FTS: 8-327-3938

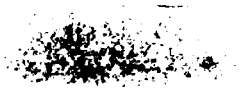
Ronald Seppala
Box 551
Amherst, NH 03031
Home: 603-673-3798
FTS: 834-6171

Robert M. Johns
NAFEC Building
ARD-142
Atlantic City, NJ 08405
Home: 609-346-3318

Jim Norton
FAA Washington, AAT-110
FTS: 426-8760

John Gournic
FAA Washington, AAF-370
FTS: 426-8350

*ETABS Field Impact Project Leader (point of contact)



EXECUTIVE SUMMARY

The Electronic Tabular Display System (ETABS) is an automated flight data presentation device designed to replace the currently used paper flight strips. The proposed system is to be located at en route sector positions and will upgrade Stage A of the National Airspace System (NAS) which is designed to maintain aircraft flight plan information. ETABS will effectively automate many of the controller's manual and verbal tasks and will result in the elimination of the flight strip printers (FSP's), computer update equipment (CUE), and their attendant activities.

An evaluation team of field personnel was selected and given the task of conducting a field impact evaluation of ETABS. This report is the culmination of the evaluation and is organized into six functional areas.

1. Impact on the Workforce — Whenever a system of this magnitude is implemented there is an expected impact on new employees, affirmative action programs, acceptance of the new system, interpersonal relationships, and labor relations which have to be addressed.

2. Technological Considerations — The team examined the technological aspects of implementation, standardization, system deficiencies, redundancy, reliability, environmental factors, expandibility, and testing.

3. Implementation — The implementation process was analyzed with its affect on NAS during the transition to ETABS. The impact areas examined were: dual system operation, selector channel usage, computer system on-line time, critical electric power, space requirements, and additional workload.

4. Operations — ETAB's effect on actual air traffic operations was considered with its impact on: safety, traffic variables, productivity, and users.

5. Training — The training of Airway Facilities and Air Traffic personnel was examined with specific interest in the retraining of certain employees, the quality of the Federal Aviation Administration's Academy training, and the provision of adequate training funds.

6. Logistics Support — System implementations' logistics effects were addressed. Specific areas of concern were: system certification, special testing diagnostics, test equipment, spare parts, and temporary storage space.

The evaluation process identified many areas of concern. This report is concerned with those items which are considered to have the most impact on the overall field acceptance of ETABS. If ETABS is to have any level of acceptance by the work force, the following negative impacts must be properly addressed. The three items of prime concern are: (1) The lack of a redundant backup system for ETABS. (2) The need for a workable installation and cutover process. (3) The lack of provisions for a dual system operation during the transition to ETABS.

INTRODUCTION

PURPOSE.

The purpose of this report is to evaluate the Electronic Tabular Display Subsystem (ETABS) and analyze its ability to replace flight strip printers and computer update equipment at the en route sector positions. A separate report describes the evaluation process developed and used in assessing ETABS.

BACKGROUND.

In 1976, the Deputy Administrator for Air Traffic and Airway Facilities initiated a project which had as its goal the establishment of strategic planning processes within the agency. One of the task groups within the project, in fulfilling its charge, developed a technology assessment process. This process was recommended for inclusion in the agency's System Acquisition Management (SAM) process in June of 1978.

In August of 1978, the Deputy Administrator suggested to the Systems Requirement Group (SRG), the operators of the SAM process, that they conduct a trial of the evaluation process. The ETABS program, which is under the SAM process, was selected as the trial vehicle.

ETABS provides a method for an electronic display of flight and related air traffic control data and the means for automatic updating of displayed data. It also allows for simplified method of message entry through use of touch-impact devices and special software logic to assist the controller in message composition.

A diagonal slice of field personnel was selected and charged with the task of conducting a field impact evaluation of ETABS using the general concepts of technology assessment. A diagonal slice team is composed of affected personnel representing as many organizational perspectives as possible. They were further charged with the task of modifying and developing the assessment and evaluation concepts in terms of a specific program (ETABS).

This report is organized into six functional areas. However, it must be understood that while each section has the general appearance of standing alone, major interactions between sections exist, and in fact, the entire substance of the report was generated in a horizontal rather than a vertical manner. Thus, the entire range of impacts was considered first, followed by the sizing or quantification of the impacts. Alternatives, expected to eliminate or substantially reduce the impacts, were generated next and evaluated by the team for feasibility. The recommendations were developed by section while the conclusions were drawn using the entire body of the report without regard to individual sections. Thus, the conclusions, in effect, represent the team judgment as to a relative order of priority or grouping in which the recommendations should be considered for implementation. It should be noted that the team

has made these judgments from a field viewpoint and recognizes the existence of other factors which may have an influence on the order of acceptance and implementation of the recommendations.

This report contains both positive and negative impact statements; however, only negative impact statements have alternatives and recommendations.

IMPACT ON THE WORKFORCE

AREA OF CONSIDERATION.

The FAA must expect an impact in the area of new employees, composition of the workforce, social programs, acceptance of the new system, interpersonal relationships, and labor relations with the implementation of ETABS. If these areas are addressed properly in our preplanning, these impacts can be minimized and in some cases eliminated.

IMPACT FACTORS.

COMPOSITION OF THE WORKFORCE. The analysis of staffing costs related to the implementation of ETABS provided by SRI International indicated a reduction of personnel and a substantial savings with the implementation of the system. In reference to that analysis, the evaluation team does not foresee a significant reduction in numbers of employees in 1983 from our present levels or in the foreseeable future in either Air Traffic or Airway Facilities. It is agreed that, with the implementation of ETABS, the present staffing levels will be sufficient to accommodate the estimated 6 percent per annum traffic growth and the projected saving of 300 million dollars will be realized through increased productivity.

NEW EMPLOYEES AND SOCIAL PROGRAMS. With the implementation of ETABS, it becomes evident that the present air traffic training program will require modification. Phase VII of this prgram, Preliminary Radar Associate/Nonradar Control Training and Assistant Controller Duties, is currently programmed for 48 weeks. The assignment of the developmental controller to assistant controller duties is unnecessary since this position will be eliminated. This will require the agency to consider changes to the present training program, the career progression ladder, and the entry level of new hires. Indirectly, the approach taken with new hires will affect the agency's air traffic predevelopmental program.

Additionally, FAA social programs could be adversely affected following the implementation of ETABS, since minorities, including women, would encounter greater obstacles in qualifying for the higher level graded entrance positions.

Alternatives.

1. Start new hires at Flight Service Stations and Towers with progression at the GS-9 level to Centers.

Advantage

This plan would resolve the nonproductive time caused by the elimination of assistant controller duties. Only minor changes to the position description would be required. The predevelopmental program could continue with assignment at the conclusion of the program to Flight Service Stations and Towers.

Disadvantage.

All employees assigned to an en route facility would have to go through a formal training program twice, doubling the cost of training, per diem, and travel. Secondly, permanent change of station costs would rise considerably. The team also felt that the constant attrition in Flight Service Stations and Towers would have an adverse effect on morale.

2. Establish an entry level of GS-7/9 at Air Route Traffic Control Centers (ARTCC's) with waiver to the GS-9 level at the end of 6 months.

Advantage.

This alternative resolves approximately one-half of the nonproductive time. Another advantage is the continued entry level at the lower grades which would not unduly restrict possible candidates from qualifying for positions on the register. Neither the predevelopmental or social programs would be adversely affected.

Disadvantage.

A waiver would be needed to reduce the 1-year ingrade requirement from GS-7 to GS-9. Also, this would solve one-half of the problem; i.e., 6 months of nonproductive time would still remain and a restructuring of the present air traffic controller training program would still be needed.

3. Provide classroom training to compensate for the lack of productive work.

Advantage.

No change to the existing grade structure is required.

Disadvantage.

Additional classrooms, both at the facility and at the Academy, would be required. Space at both locations is already at a premium. Also needed would be a large increase to the instructor staffs. Another cost factor would be the increase in per diem and, due to the extended training, we could expect a rise in morale-related problems.

4. Change the entry level to GS-9.

Advantage.

An entry level of GS-9 would eliminate higher training costs and provide for continuous training and progression with no real loss in production.

Disadvantage.

This alternative would require a waiver to hire at the higher grade. If a waiver was obtained, it would reduce the number of qualified candidates on the register for en route controller positions and increase the salary cost. It would also necessitate a complete restructuring of the predevelopmental program and would limit our placement options for predevelopmentals.

Recommendation.

After considering all the alternatives listed, it is recommended that Alternative 2 be adopted. It is the team's consensus that it would be the most feasible solution as it reduces the nonproductive time by half; and with some minor adjustments at the Academy and field facilities, it could strengthen the training program by giving added emphasis to those problem areas identified by training departments at the Academy and field facilities. There is already a requirement to do some restructuring of the Academy training to implement the new Radar Training Lab. The evaluation team suggests, as this restructure develops, the Academy give some thought to future program planning beyond the 5 weeks required for addition of the Radar Training Lab in the curriculum.

CURRENT WORKFORCE ACCEPTANCE OF ETABS. Since ETABS will replace the difficult-to-maintain Flight Strip Printer Subsystem and will provide significant operational advantages, it is visualized as a time-efficient tool; and the Airway Facilities personnel have long recognized the need to replace the slow mechanical devices with up-to-date technology. As a result, it is expected that ETABS will be accepted by the workforce.

The participation of air traffic controllers in the development of ETABS is a positive action toward acceptance of the subsystem. Action should be taken to include the Airway Facilities technicians in all future actions associated with ETABS. Consideration should be given to consult the unions, the establishment of onsite Air Traffic and Airway Facilities coordinators, the solicitation at the field facility for input to the draft document, and the need to educate the workforce on the coming system.

Alternatives.

1. Consult with the unions involved.

   Advantage.

   Through consultation, the unions might be able to give some meaningful input that will help in acceptance.

   Disadvantage.

   Consultation is a time-consuming process and that could delay the agency planning to some extent.

2. Local onsite Air Traffic and Airway Facilities focal point.

Advantage.

Establishing focal points at each facility from both Air Traffic and Airway Facilities will greatly assist in planning and will reduce false starts.

Disadvantage.

None.

3. Solicit field input on draft documents.

Advantage.

With workforce input and participation, less modification to the end product can be expected.

Disadvantage.

Input requested from field facilities, if accepted, might delay the final system. But, not accepting that input, for whatever the reasons, unless explained, could have a detrimental effect.

4. Air Traffic and Airway Facilities Evaluation of Prototype at the National Aviation Facilities Experimental Center (NAFEC).

Advantage.

If field personnel are given an opportunity to become involved in the prototype testing, possible deficiencies will be identified early and corrected which would result in less modification to the final product. Also, more workforce ownership could be expected.

Disadvantage.

Any travel for field personnel will have an affect on the facility staffing which could result in overtime expenditures and costs for per diem.

5. Educate the workforce on the system using public relations films, slides, video tapes, etc.

Advantage.

Through the use of a good public relations program, system acceptance could be helped by creating a market.

Disadvantage.

The problem with any public relations program, as experienced with the Direct Access Radar Channel (DARC) system, is oversell. Care should be taken to sell only that which can be delivered.

Recommendation.

All of the above alternatives are recommended.

INTERPERSONAL RELATIONSHIPS FOR AIR TRAFFIC PERSONNEL. ETABS will relieve the manual controller of up to 30 percent of the routine functions which are now required. This will allow the radar and manual controllers to jointly devote more of their time to radar traffic.

Recommendation.

Revise the manual controller's job description to define his duties in a way that will strengthen the sector team concept.

INTERPERSONAL RELATIONSHIPS FOR AIRWAY FACILITIES PERSONNEL. ETABS may add to the occasional friction between technicians caused by deficiencies in diagnosing problems with the interface between systems. Inequitable workload distribution also contributes to technician dissatisfaction.

Alternatives.

1. Improve interface training.

   Advantage.

   Increase technician proficiency and reduce restoration time.

   Disadvantage.

   Increase cost.

2. Furnish adequate interface diagnostics.

   Advantage.

   Reduce uncertainty of repair responsibility and decrease outage times.

   Disadvantage.

   Increase cost.

3. Balance the equipment variety and quantity workload among technicians.

Advantage.

Remove a source of dissatisfaction and maintain higher proficiency.

Disadvantage.

None.

Recommendation.

All three alternatives are recommended.

LABOR RELATIONS. The affected workforce is highly unionized; therefore, early coordination, orientation, and consultation is considered a must. The FAA should expect the unions to be interested in the functional design, system parameters, scheduling, and training. One area that must be considered sensitive is, when ETABS becomes operational, fewer people will be required to service system growth.

Alternatives.

1. Involve the union as an interested party.

   Advantage.

   This approach would create a climate of mutual trust, respect, and confidence. If this is done properly, the FAA would experience fewer grievances. And, with good input from the unions, the quality of the system would also be improved.

   Disadvantage.

   The union reaction could be negative, and that information shared could be used to the detriment of the program. Also, this approach could delay the process.

2. Consult with the unions.

   Advantages and disadvantages are the same as alternative 1 above. However, the approach used would be different.

Recommendation.

Both alternatives are recommended as good approaches with reservation. In some areas care must be taken to insure that no misunderstandings surface as to how much the unions can recommend changes. Whether to consult or involve the union must be determined on each issue individually.

SOFTWARE SUPPORT STAFFING. The SRI International cost analysis of ETABS indicates a reduction in maintenance personnel, but does not address the software support for ETABS. For example, the implementation of the Maintenance

Automated Reporting System (MARS) requires the dedication of one System Performance Specialist with no increase in staffing. The software maintenance of Direct Access Radar Channel will also require an undefined workload on these same resources.

Alternatives.

1. Have the National Field Support Group (NFSG) provide complete software support.

Advantage.

Using this approach would eliminate the need for additional staffing at the facilities.

Disadvantage.

There would be a delay built in the response time to problem solving. It would, in all likelihood, require an increase in staffing in the organizations which make up the National Field Support Group.

2. Have the present staff assume the added responsibility of ETABS software support.

Advantage.

No increase in facility or National Field Support Group staff and the cost would be less to maintain the program.

Disadvantage.

There would be an increased workload and very probably decreased efficiency as well as possible morale problem.

3. Airway Facilities staffing must be increased by at least one per ARTCC to support the additional software diagnostics.

Advantage.

The additional staffing would handle the increased workload in an efficient manner and prevent a deterioration of morale.

Disadvantage.

The increase in staffing would generate an increase in cost.

Recommendation.

Alternative 3, to increase the staff by one System Performance Specialist, is recommended.

COMPUTER OPERATORS. The physical location of the ETABS equipment within each ARTCC may cause a problem with current computer operator staffings. Presently, there is only one Central Computer Complex (CCC) operator available on most shifts.

It appears that very little operator intervention will be required for ETABS air traffic control operation. Operator intervention will normally be confined to: initiating ETABS startup, magnetic tape changes, collecting and distributing line printer output, loading the printer and input/output terminal paper, and changing line printer and input/output terminal ribbons.

Design goals are to provide an interface processor software system which is fully automatic and can function with no operator intervention. The interface processor software will also have the design feature to permit full operator intervention of ETABS control and reconfiguration.

By locating the Central Computer Complex and ETABS input/output terminal and line printers in a common location and by careful consideration of operational requirements versus system integrity to the amount of operator intervention or monitoring required, the need for additional computer operators will be minimized.

Alternatives.

1. Install the ETABS equipment, Common Equipment Group (CEG), in the same area as the Central Computer Complex system console.

   Advantage.

   The current workforce can perform the increased workload.

   Disadvantage.

   Some facilities may not have sufficient room for this dual installation.

2. Increase computer operator staffing by five.

   Advantage.

   The additional workload can be handled regardless of where the equipment is installed.

   Disadvantage.

   The cost of increased staffing.

Recommendation.

It is recommended that ETABS be located where it can be operated by the present staff. In addition, those unique ARTCC's where this cannot be done, an increase in staffing recommended.

TECHNOLOGICAL CONSIDERATIONS

AREA OF CONSIDERATION.

ETABS, like many systems integrated into the air traffic control environment, has been initiated to fulfill a specific need. For this reason many new concepts, when implemented, failed to consider the relationship of the new equipment to the total ongoing system. This philosophy also appears to be evident with ETABS. Experience has shown that certain basic technological areas of new systems must be assured or guaranteed. It is mandatory that ETABS be reliable, that adequate backup be provided, and that the integrity of the system be assured during implementation. This portion of the impact study describes conditions which may be encountered in the area of standardization, system deficiencies, redundancy, reliability, etc.

IMPACT FACTORS.

STANDARDIZATION. The growth of NAS has been achieved through the proliferation of systems with little regard for commonality except for interfaces. As more and more complex systems are added to the inventory, the expertise and proficiency of the workforce decreases. Two hundred Airway Facilities technicians will be given another major, unique system with different equipment design and different computer language. Since the technician will be required to become proficient on ETABS, his overall proficiency will very likely decrease. This problem could be minimized by the following:

Alternatives.

1. Design ETABS using modular construction which allows replacement without the complete removal of the Sector Equipment Group (SEG).

   Advantage.

   This would improve maintainability, reduce downtime, and reduce requirement for onsite component maintenance.

   Disadvantage.

   The disadvantages to this alternative are increased major components, increased cost of spares, and possible increased system outage time due to Depot response time.

2. Establishing and maintaining a proficiency training program.

   Advantage.

   Establishing and maintaining a proficiency training program will increase system reliability and increase technician efficiency.

Disadvantage.

This training will be costly and increase the already heavy training program.

3. Completely standardized equipment.

Advantage.

Standardization of equipment would require less training, less documentation, and would minimize requirement for spares.

Disadvantage.

Standardizing would cause our systems to lag behind the state-of-the-art. A procurement problem could result since sole source could be required or competition could be reduced. It is also possible that system cost could be increased.

Recommendation.

Alternative 1 is recommended as the primary solution to this problem. The equipment should be designed using the modular concept.

As a secondary recommendation, alternative 3 is suggested. Equipment should be standardized where possible without impacting the operational capability of the system. It is also advised that serious consideration be given to using the same equipment for the Terminal Information Processing System (TIPS). It should be noted that many times systems are procured in the same time period with no apparent thought of standardization. Because of the seriousness of the problem, alternative 2 is also recommended as a final step to reduce the impact of ETABS. The FAA should establish and maintain proficiency training for Airway Facilities personnel on the ETABS equipment.

SYSTEM DEFICIENCIES. Due to the critical need for flight data and the impact upon the total air traffic control system, it is vital that the system be reliable. Although reliability of the proposed system can be predicted, the evaluation team questions the accuracy of the SRI International cost analysis, especially for the first year of operation. Historically, first year availability/reliability is very poor due to design problems, supply support, etc. ETABS must be designed and configured to assure availability of flight data to the controllers.

Maintainability of FAA systems has varied from excellent to very poor. A number of system and/or component deficiencies, noted in prior systems, have interferred with effective maintenance and, thus, impacted system availability. They are listed below so that they can be considered in the specification for ETABS.

1. Overhead mounting of heavy components such as power supplies and logic units which are difficult and awkward to replace or work on.

2. External cable connectors have not been:

   a. Keyed for proper matching.
   b. Sturdy enough for repetitious connections.
   c. Quick-disconnect type.
   d. Mounted with sufficient space for hand clearance.

3. Modules (keyboards, displays, and power supplies) have not been removable from the console by quick-release fasteners.

4. Adjustments for alignment of displays have not been accessible from the front maintenance panel and tamper free.

5. Lack of a built-in test pattern for each display and functional diagnostics for keyboards at the operational sectors.

6. Heavy, large units such as displays are mounted and removable from the front of the console, causing interruption to the controller at the sector.

7. Sector components such as keyboards and touchpanels have not been impervious to spilled liquids or obstruction by dirt or debris.

8. Display surfaces have been permanently defaced by writing instruments; e.g., a grease pencil.

9. Printed circuit card connectors are not keyed for positive, accurate alignment.

10. Keyboard components, such as mechanical character keys and their labeling, are subject to short life. Keyboard units require complete disassembly to replace one character key cover.

11. Peripheral devices such as tape drives, printers, and disc drives have been of poor quality. The short term benefit of low cost is more than offset by greatly increased maintenance costs.

12. Lack of a complete diagnostic test bench and functional test sector in the maintenance area.

13. A complete set of diagnostic software has not been provided on a timely basis.

14. A complete set of maintenance procedures has not been provided on a timely basis.

15. Equipment has been manufactured with nonrepairable modules, such as encapsulated power supplies.

16. Lack of proper tools for soldering repair of miniprocessor printed circuit boards.

17. Lack of compatibility between different systems' magnetic tape drives and formats.

Alternatives.

1. Design ETABS with a modular replacement maintenance concept.

Advantage.

This will reduce the time to replace and repair units as well as increase the ease of maintenance.

Disadvantage.

The main disadvantage is the possible increased cost of equipment.

2. Task contract specification writers to review and consider the previously listed descrepancies.

Advantage.

Reduce the number of inherent system problems.

Disadvantage.

None.

3. Conduct a maintenance demonstration with field personnel on the engineering model at NAFEC. This should be early enough to assure input to the production specifications.

Advantage.

It will reduce the number of inherent system problems as well as the number of future modifications to equipment.

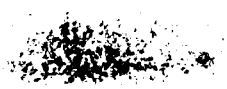
Disadvantage.

There will be the additional cost of sending field personnel to NAFEC.

4. Emphasize maintainability and reliability in the production equipment specifications. This should include the elimination of single-point fault items. The system design should provide online diagnostics to isolate defective modules.

Advantage.

This will increase maintainability and reliability.



Disadvantage.

There is a possibility of initial increase in the cost of equipment.

Recommendation.

Since the above alternatives tend to consolidate the overall concerns of field personnel and since the disadvantages are not prohibitive, it is recommended that each solution be given full consideration.

LIGHTING, GLARE, AND REFLECTIONS. On every display system implemented into the air traffic control system, major problems of lighting, glare, and reflections have existed. This has been a problem since the use of VG's and has continued to be a problem with each successive system. For example, considerable funds were spent to resolve the Plan View Display (PVD) problem and, to some degree, the problem still exists. Every controller will be severly affected by the extent of lighting and reflection problems of ETABS.

Alternatives.

The following are alternatives to minimize the lighting, glare, and/or reflection problems.

1. Accomplish lighting tests at NAFEC on the engineering model and confirm results at an operational facility prior to production specification.

Advantage.

The alternative to test the lighting at NAFEC and at an operational facility would tend to minimize the problem. It would provide a visual indication that every effort is being made to provide an acceptable system. Working conditions would be improved and there would also be a corresponding improvement in employee morale. As a minimum, the SEG should be tested at an operational ARTCC.

Disadvantage.

The disadvantage is the added cost of the effort and a possible delay in the ETABS production contract unless this effort was expedited.

2. Reduce ambient lighting at Centers.

Advantage.

Reducing the ambient lighting might reduce the glare and reflection problem.

Disadvantage.

Overall employee satisfaction with his working environment would deteriorate. Employee friction as well as eyestrain would increase.

3. Adjust display angles for reduced glare.

   Advantage.

   Adjustment of display angles would reduce, but not solve, the problem.

   Disadvantage.

   The resulting display angle may not be compatible with the present Plan View Display installation. The effort to design and implement a satisfactory display angle would be costly and would still not resolve the problem.

Recommendation.

It is recommended that NAFEC test the lighting, glare, and reflection of ETABS displays and that the resulting recommendation be confirmed at an operational Center prior to the production contract.

COMPUTER TIME. There is an operational requirement to study flight progress strip data. These studies support various surveys along with incident and error analysis. Provisions must be made for ETABS data reduction. This function could be accommodated through any of the following means:

Alternatives.

1. Provide capability to perform data reduction and analysis on ETABS.

   Advantage.

   Performing Data Reduction and Analysis (DR&A) on ETABS would not impact the existing IBM 9020 computer time and would provide the reduction on a timely basis. The potential problem of competition for computer time would be averted.

   Disadvantage.

   None.

2. Have data reduction and analysis done by National Field Support Group.

   Advantage.

   Accomplishment of Data Reduction and Analysis at National Field Support Group would also alleviate the need for IBM 9020 time.

   Disadvantage.

   The following disadvantages would result:

a. Cost of data link between each facility and the National Field Support Group.
b. Increase in response time since the National Field Support Group could not be completely responsible to each facility.
c. Increase in staffing requirements at the National Field Support Group.

3. Provide the capability for ETABS Data Reduction and Analysis using the IBM 9020 resources. This would require longer midnight shutdowns of the IBM 9020.

Advantage.

None.

Disadvantage.

a. Reduces the time when the facility will be available for operational purposes.
b. Cost of a new software program.
c. Reduces the period when the facility will be available for maintenance.

4. Designate master sites throughout the country for Data Reduction and Analysis.

Advantage.

None.

Disadvantage.

a. A special data link would be required between the master site and each facility it serves.
b. Competition for time for Data Reduction and Analysis.
c. Increased staffing for the master site.
d. Increased response time.

Recommendation.

The team recommends alternative 1, that ETABS should include the capability to perform all required data reduction and analysis.

BACKUP/REDUNDANCY FOR ETABS. One of the most important areas of concern affecting ETABS is in the area of backup or redundancy. This concern is manifested as a failure of one sector all the way to the possibility of an ARTCC-wide failure of ETABS. With an ARTCC-wide failure of the ETABS, the Flight Data Processing (FDP) function is lost. Conversion to any manual system could be a major problem. The transition process should be carefully tested in the semioperational environment of the engineering model.

A failure of ETABS, with no backup, affects the total air traffic environment. It basically results in a total deterioration of air traffic control services in that Center area. This loss of data would result in delays, holding, etc.

Alternatives.

The following alternatives for Backup/Redundancy were considered:

1. In the case of a SEG failure, provide capability to transfer data from any sector to any other sector at supervisory option.

Advantage.

The advantage of being able to transfer data from any sector to any other sector are:

a. Provides continuity of the sector operation.
b. Provides assurance of system credibility.
c. Assists in maintaining assurance of safety and capacity of the system.

Disadvantage.

The alternative requires controller relocation from failed sector to another sector and increases software maintenance liability.

2. In the case of a total ETABS failure, provide flight data information on a high speed printer in parallel with or without the ETABS display. The flight data information should be in an acceptable user format.

Advantage.

a. Provides continuity of sector operation.
b. Provides assurance of system credibility to controller.
c. Assists in maintaining assurance of safety and capacity of the system.

Disadvantage.

This alternative has the disadvantage of added cost and requires expansion of Central Computer Complex resource.

3. In the case of a total ETABS failure, design the system to provide a data freeze at each SEG for emergency operations.

Advantage.

a. Provides short term continuity until backup data is available or system is restored.
b. Enhances safety.

c. Provides continuity of sector operation.
d. Provides assurance of system credibility (sets controllers' mind at ease).
e. Would assist in maintaining the safety and capacity of the system.

Disadvantage.

a. Limited capability; on certain type failures, this capacity is lost.
b. Expense in maintaining hardware and software.

4. In the case of a total ETABS failure, provides capability to print from bulk storage or ETABS discs output strips on a high speed printer. Possibly an offline minicomputer could be used to accomplish this function.

Advantage.

a. Continuity of sector operation.
b. Credibility of the system will set the controllers' mind at ease.
c. Would assist in maintaining the safety and capacity of the system.

Disadvantage.

a. Limited to data available at the time of the failure.
b. Longer response time than the alternative to provide strips on a high speed printer in parallel with ETABS.
c. Increased costs in software and hardware.

5. Design the system to operate using two independent cathode-ray tube (CRT) displays at each position. Provide software filtering to display critical data on the remaining displays in the case of a failure to one CRT or sector equipment group.

Advantage.

a. Continuity of sector operation.
b. Credibility of the system will set the controllers' mind at ease.
c. Would assist in maintaining the safety and capacity of the system.
d. More maintenance flexibility.
e. Continuity of format.
f. Minimize physical relocation of controllers.

Disadvantage.

a. Increased design complexity.
b. Increased costs.

6. In the case of a total failure to provide FDP, provide for manual preparation of strip capability in each area.

a. Continuity of sector operation.
b. Credibility of the system will set the controllers' mind at ease).
c. Would assist in maintaining the safety and capacity of the system.

Disadvantage.

a. Much slower than any other alternative.
b. Accuracy is diminished.

Recommendation.

All of the alternatives are recommended because each is a solution to different levels of equipment failure.

SYSTEM MODULARITY. Modular construction and functional modularity are significant issues in the development of ETABS. The system sector configuration can be expanded by groups or individual sector positions. The main processors are dual and many components are identical. However, it is not known if ETABS will operate in a degraded mode or if some flight data processing can be achieved if the IBM 9020 computer fails. A divided data display area with independent operational capability is considered essential to reduce the impact caused by a failure at a sector by part of the sector equipment group.

Attention should be given to functional modularity in the final design to provide fail-safe capability.

The ease with which equipment can be replaced or adjusted at the operating position will have a direct effect on the controllers performing air traffic duties.

Alternatives.

1. Provide complete modularity within the sector. This should include dual displays (two independent CRT's).

Advantage.

a. Ease of maintenance.
b. Reduction in installation cost.
c. Reduction in confusion within the sector.
d. Reduction in sector downtime.

Disadvantage.

A disadvantage to providing modularity could be an increase in equipment cost since each unit may need an individual housing.

2. Provide a self-contained console as specified in the engineering model.

Advantage.

The only advantage in a self-contained console could be a decrease in equipment cost since each unit will not need an individual housing.

Disadvantage.

Increased sector downtime, less maintainability, and increased installation cost.

Recommendation.

Alternative 1 is recommended; i.e., that the production ETABS be designed and implemented with complete modularity within the sector.

It is further recommended that a team made up of regional Airway Facilities maintenance and installation personnel be tasked to look at this problem in detail during the testing at NAFEC. Consideration should also be given to the type of cabling/connector used in the sector equipment. These cables and connectors should be quick disconnect for ease of maintenance with high reliability.

COMPUTER LANGUAGE. A great deal of concern has been expressed by the team because the language of the engineering model is planned to be different from the existing center computer. A different computer language would require 80 existing computer programmers and some technicians to learn a new computer language. The proficiency of these individuals would decrease because of the added responsibility.

Alternatives.

1. Require ETABS to utilize the same language used in existing equipment.

   Advantage.

   a. There will be no requirement for additional training.
   b. Existing personnel can maintain the software proficiency.
   c. Task can be accomplished with existing staffing.

   Disadvantage.

   a. Cost of initial system may be higher.
   b. Could decrease computer efficiency.
   c. Ignores software state-of-the-art improvements.

2. Select a standard language for ETABS and all future systems.

   Advantage.

   a. Training can be done at one time.

b. One-time cost for documentation.
c. Permits greater personnel proficiency.

Disadvantage.

a. Reduces motivation and productivity.
b. May constrain future system development.
c. The selection process for a standard language could be costly.

3. Accept the language recommended and available from the contractor.

Advantage.

The alternative to accept language recommended and available from the contractor would be cost effective and would permit state-of-the-art language.

Disadvantage.

It fosters the requirement for training, causes a decrease of programmer efficiency, and it further compounds the present problem.

Recommendation.

Although it was the consensus of the team that computer language should be standardized, we could not recommend a viable solution to the stated problem. For this reason, we recommend that contractor-recommended language be accepted. It is further recommended that the FAA investigate the needs and/or feasibility to establish standardization in this area.

ETABS FLEXIBILITY TO EXPAND. The requirement for future expansion of ETABS was recognized. This flexibility should be designed into the system wihout requiring modification. Some possible interfaces which may be needed are Flight Data Entry and Printout Subsystem, Direct Access Radar Channel, Display Channel Processor, Automated Radar Terminal Facilities and Adjacent Centers.

Alternative.

1. Establish a Master Plan to give direction as to what tasks and functions are to be achieved by automated systems.

Advantage.

Integration of several large, expensive systems including: Remote Maintenance Monitoring Systems, Automated Flight Service Stations, and Terminal Information Processing System which are not being considered in connection with ETABS.

Disadvantage.

None.

2. Develop operational requirements for ETABS and issue firm objectives prior to the initiation of the ETABS program with full consideration of the total system requirements and system interfaces.

Advantage.

Long-run cost savings in systems planning and development.

Disadvantage.

None.

3. Field personnel provide input to tie together total system requirements.

Advantage.

Other system interface requirements may be determined at this time.

Disadvantage.

Increase costs due to possible system redesign.

4. Expand ETABS to provide for future internal processing functions to perform some of the 9020 activities.

Advantage.

Extend the useful life of the IBM 9020.

Disadvantage.

Added ETABS cost.

Recommendation.

All the above alternatives are recommended for adoption.

FIELD REPRESENTATION IN TESTING. Several thousand Configuration Control Decisions (CCD's) and NAS Change Proposals (NCP's) have been generated by field personnel. These modifications have cost millions of dollars to implement. Each new system that the FAA procures goes through a long line of modifications.

Alternative.

During testing of the ETABS engineering model, Air Traffic and Airway Facilities field personnel must be given the opportunity to flag functional and design deficiencies at the engineering model level.

Advantage.

a. Field participation should reduce NCP's and CCD's and add to design improvement. Also, it should improve field acceptance.
b. These representatives could generate changes that would modify the production specifications to eliminate contractual pitfalls.

Disadvantage.

The cost of travel and overtime expenditures.

Recommendation.

This solution is highly recommended by the field evaluation team.

ENVIRONMENTAL DATA. The ETABS technology is seen as a positive response to the existing system deficiencies. Air traffic control operations with ETABS should reduce errors in communications, improve response time, and increase capacity for handling data for air traffic control. Since ETABS replaces flight strip printers, which are slow mechanical devices with a high failure rate and deteriorating reliability, there should be an increase in system performance. In addition, there will be an reduction of noise due to the elimination of these printers. This noise reduction will improve the working environment for FAA employees.

IMPLEMENTATION

AREA OF CONSIDERATION.

The implementation process of any new technological changes has historically created impact on operations. Many areas will be impacted in the transition from the Flight Strip Printer/Computer Update Equipment (FSP/CUE) system to ETABS; i.e., Central Computer Complex Core Storage, Selector Channel Utilization and Computer On-line Time, Critical Electrical Power, Installation and Cutover Method, Space, and Workload.

IMPACT FACTORS.

1. Dual System Operations.

It must be required that the Central Computer Complex support both ETABS and the Current Flight Strip Printer and Computer Update Equipment system during the shakedown and cutover period. The current NAS Stage A Program will require additional subprograms to handle the new ETABS selector channel usage. Additional IBM 9020 storage will be required to support the flight data information for ETABS and the parallel flight strip printer subsystem during implementation. Operation of ETABS during the installation period will require approximately 3,000 to 5,000 words of core. If this core is not available the total NAS en route automation system will be seriously degraded.

Alternatives.

1. Provide the required storage by the addition of another storage element to the IBM 9020 system.

Advantage.

This solves the problem since additional storage elements have been ordered.

Disadvantage.

None.

2. Define existing core needed for ETABS and reserve it for ETABS.

Advantage.

This would assure timely implementation.

Disadvantage.

The loss of certain subprograms to make room for ETABS.

3. Delay the implementation of ETABS until the IBM 9020 replacement is available.

Advantage.

a. This may permit greater standardization with its obvious benefits.

b. Reduce or eliminate any possible interface problems between the two systems.

c. There would be only one implementation process and this should reduce contract cost.

Disadvantage.

It would cause the delay of a system that is needed now. Some other Flight Strip Printer replacements would be required and it would delay the safety enhancement of ETABS. In addition, inflation would add to the cost of ETABS if it were delayed.

Recommendation.

Alternative 1 is recommended as the permanent solution to the problem. However, alternative 2 can be employed if any delays or problems prevent the timely installation of the additional storage element.

SELECTOR CHANNEL. The selector channel software management is currently a weak link in the NAS Automated System due to problems with interfaces between various elements of the existing system. Adding ETABS to the selector channel will significantly aggravate the already weak link and will result in degrading both the existing systems as well as ETABS.

Alternatives.

1. Use the multiplexer channel with burst mode capability, instead of the selector channel to interface the IBM 9020 and ETABS.

Advantage.

This would not create an additional load on the current selector channels.

Disadvantage.

None.

2. Add a third selector channel to two of the three IBM 9020 Input/Output control elements (IOCE's).

Advantage.

This would prevent the increase load on existing IBM 9020 selector channel capabilities.

Disadvantage.

The current cost of adding two channels per ARTCC would be approximately 2 million dollars.

Recommendation.

Alternative 1 is the preferred recommendation. A study has been performed on the addition of selector channels and the results have not been published to date.

COMPUTER ON-LINE TIME. There will be an impact on normal operations caused by competition for IBM 9020 computer time for testing during implementation.

Alternatives.

1. Remove the IBM 9020 from the operational system and run in a backup mode while ETABS is being tested.

Advantage.

This should reduce the possibility of system errors caused by debugging ETABS using an operational system.

Disadvantage.

This could delay IBM 9020 system updates and charting dates. This will impact ETABS testing and will extend the overall testing period. Because we are using the IBM 9020 for testing, we would operate in a degraded mode with the broadband.

2. Test ETABS on-line with the IBM 9020.

Advantage.

This would eliminate the competition for IBM 9020 computer time.

Disadvantage.

This testing configuration would create the possibility of system errors.

Recommendation.

Alternative 1 is recommended.

CRITICAL ELECTRICAL POWER.

In the event that sufficient critical power is not available, a substantial impact to the existing center operation will result. Therefore, it should be ascertained whether the power requirements are available with the addition of ETABS to the critical bus.

Alternatives.

1. Task the appropriate organization to conduct a study to determine the power needs for each ARTCC. The study should include all the future systems that are planned; e.g., DARC, AFSS, RMMS, etc.

Advantage.

The results of the study would determine if a problem does exist in this area before the implementation of ETABS. This would allow sufficient time to propose solutions to the problem.

Disadvantage.

The disadvantage is the cost of the facility-by-facility study.

2. Design the implementation and cutover plan at each ARTCC to shift ETABS equipment onto the critical bus as the Flight Strip Printer/Computer Update Equipment is replaced.

Advantage.

There is no delay in the implementation of ETABS if sufficient critical bus capacity is unavailable.

Disadvantage.

None.

Recommendation.

Both alternatives are recommended with emphasis on alternative 1.

THE INSTALLATION AND CUTOVER PROCESS. The installation and cutover process of ETABS will have an adverse impact on operations. There are many factors to support this; i.e., the lack of a planned sector-by-sector cutover or all-sector cutover at one time, combining or relocating ATC functions to enable console availability for modification to accommodate ETABS equipment, high levels of noise in the control room and RF interference from electric hand tools.

Alternatives.

1. Install ETABS in dynamic simulation (DYSIM) first, then implement on a sector-by-sector basis.

Advantage.

This will provide for advance training, reduce the chances of adverse impact to the operations system, and reduce test time on the operations flow.

Disadvantage.

A disadvantage to this would be the adverse impact to current agency training.

2. Design the software so each sector can be operated individually.

Advantage.

This will allow relocating data from one sector to another for resectorization.

Disadvantage.

None.

3. Use existing M1 controller consoles with ETABS modular components.

Advantage.

This would simplify implementation and reduce installation cost.

Disadvantage.

None.

4. Provide a portable sound booth to be used by the implementation team. This sound booth would prevent the noise caused by the modification of a sector position from interfering with normal operations.

Advantage.

This would reduce installation noise in the operations quarters.

Disadvantage.

This has been tried before and was not successful.

Recommendation.

Alternatives 1, 2, and 3 are recommended.

SPACE REQUIREMENTS. The physical location of the ETABS computer is of primary concern. If this equipment is located away from the present central computer area, it would require additional computer operators and/or electronic technicians to monitor the system in addition to performing off-line support jobs and replacing computer recording tapes. In the event that this equipment is to be located in the central computer area, a complete realignment of this area could be required.

Space in the control room will have to be identified for temporary operation of either ETABS or the existing system. Also, space for tape storage is required and must be identified.

Recommendation.

It is recommended that space requirements be studied and identified for each ARTCC.

WORKLOAD. The installation and implementation process associated with ETABS represents an additional workload impact on the workforce. This impact will manifest itself in several ways; i.e., 30 percent more facilities and engineering (F&E) manhours and 10 percent more operations manhours will be required for ETABS planning, testing, and shakedown above the amount allocated for the implementation of ETABS. This time will be required by the local workforce to coordinate these activities.

Alternatives.

1. Establish an ETABS Airway Facilities and Air Traffic coordinator.

   Advantage.

   Focal point for ETABS activities.

   Disadvantage.

   Additional workload assumed.

2. Develop a comprehensive implementation plan for all Centers.

   Advantage.

   Standard, timely implementation plan.

   Disadvantage.

   None.

Recommendation.

Both alternatives 1 and 2 are recommended.

OPERATIONS

AREA OF CONSIDERATION.

The discussion of how the addition of ETABS will affect the actual operation of the Air Traffic System describes conditions which may be encountered in safety, traffic variables, system capacity, productivity, and impact to users. These areas are extremely difficult to forecast without intimate knowledge and a detailed analysis of ETABS.

We see a positive impact in all areas of operations, and recommend adoption of the ETABS as soon as possible throughout the ATC system.

IMPACT FACTORS.

SAFETY. Although some measure of conjecture is present, impact has been expressed as objectively as possible. Safety is always a highly sensitive area in proposing changes to the Air Traffic System. The safety results of new systems cannot be accurately predicted; however, considering safety from the viewpoint of moving aircraft, the evaluation team believes ETABS will process and distribute information more accurately and in a more timely manner while reducing stress on the present automation system, thus improving safety. The team is unanimous in its belief that ETABS will enchance safety.

As in the current system, the capability to audit the performance of the system and review and reconstruct situations will be possible which will indicate the true safety enhancement.

TRAFFIC VARIABLES. The implementation of ETABS in the Air Traffic System should reduce problems encountered with traffic variables such as the ratio of instrument flight rules (IFR) to visual flight rules (VFR) and the mix of various types of aircraft. ETABS will provide faster reaction to a dynamic traffic situation by providing the controller with a flight data display which is more accurate and easier to maintain. The addition, deletion, and revision of data can be automatic. The options of displayed data can eliminate superflous information which now must unavoidably be inspected. Better service can be provided to IFR users, especially in the unforeseen shifts in traffic flows or changes in departure and destination requests. To the extent that IFR air traffic problems can be resolved in a more timely manner, more and better service can be provided to VFR traffic, allowing more aircraft into the system.

SYSTEM CAPACITY AND PRODUCTIVITY. The evaluation team found that one major factor remains constant. ETABS will not change separation standards; therefor, total system capacity in terms of airspace remains the same. However, system capacity in terms of efficiency will increase.

This increase in efficiency is foreseen; in part, because ETABS will automate many functions now accomplished by the manual controller providing time for him to assist the radar controller. The "D" controller should have up to 30 percent more time to be aware of the ATC situation and to interact with his teammate. The two-man interactive sector will result in an improvement in the application of ATC separation standards and provide the opportunity for a decrease in ATC errors.

Recommendation.

The team recommends that the position description for manual controllers be revised to provide clarification of duties to strengthen the sector team concept. This will improve productivity, enchance safety, and improve morale through job satisfaction. The FAA may expect a possible adverse reaction in the form of union resistance to what they view as added responsibility without added compensation.

COST CONSIDERATION. In the operation of an ETABS Center, the need for the supporting assistant controller positions is eliminated along with the paper flight progress strips and their holders. Since flight data will be displayed electronically, there is no longer a need for special pencils and pens. Not considering personnel costs associated with the maintenance and logistics of flight strip printers, ETABS will provide savings of approximately 450,000 dollars per year for leased services for 300 telephone company switching system positions, 270,000 dollars for flight strip printer paper, and 27,000 dollars for strip holders. This amounts to an estimated 750,000 dollars savings per year in leased services and strip printing.

IMPACT TO USERS. ETABS, as a new subsystem of NAS will place no new procedural, hardware, or training requirements on users of ATC. In operation, ETABS will be essentially invisible to users except in expected improved services. With ETABS, the system should be more efficient than at present and could improve our response to conservation and economy measures with a reduction of user operating cost. Fuel savings will result from improved services; e.g., optimum routing and less delays from traffic saturation. The improved services will be approximately equal to the increased amount of traffic the ATC system will be able to absorb with ETABS.

TRAINING

AREA OF CONSIDERATION.

This part of the report describes conditions which may be encountered in the training of Airway Facilities and Air Traffic personnel.

IMPACT FACTORS.

AIRWAY FACILITIES TRAINING. ETABS-associated training will surface concern among the Airway Facilities workforce in a number of respects. The extended duration of training courses is a strong deterrent to many technicians. In addition, there is a problem of a maturing workforce and the inability to readily absorb the changing technology; e.g., microprocessing, programming, and plasma displays. There is a general resentment to the requirements for additional training and the larger scope of equipment responsibilities. These long courses are seen as advantageous to the agency, while the technician has to suffer the sacrifices of long separation from family and the expenditure of great amounts of learning effort.

There are 200 technicians that will be affected by ETABS. At least 90 percent of these 200 technicians will be impacted by problems associated with the length of school due to family problems, morale, housing, and transportation. There will also be an impact of additional work back at the facility in terms of overtime to compensate for the training. Cost of this overtime is estimated to be in the area of 400,000 dollars on a national basis.

Alternatives.

1. Provides ETABS in a modular design which limits itself to replace maintenance concept, no field repair.

   Advantage.

   Use of this alternative will reduce the length of training required for field technicians, decrease maintenance time on operational systems, and decrease total training costs.

   Disadvantage.

   This alternative will increase the logistics problem if components are all repaired at a central point. This concept will also create a loss of overall proficiency at field sites by removing the actual repair tasks.

2. Provide a computerized self-study education system onsite.

Advantage.

This alternative could provide for greater system proficiency while reducing resistance to training, thus improving morale. Training costs can be reduced in terms of per diem and Academy instructors.

Disadvantage.

Providing a complete package at each site could be a costly alternative. It would increase overhead costs at each facility for maintenance and time.

3. Provide for family travel with privately owned vehicle (POV) as an option.

Advantage.

This option would improve morale and decrease dropouts from Academy courses because of family problems.

Disadvantage.

As an alternative, this one is costly, adding family and POV to official travel. More time is spent away from the facility with a resulting loss in overall productivity. A problem could be created in scheduling individuals for school.

4. Break up long courses into a number of shorter courses.

Advantage.

This will increase morale by requiring less time away from the family.

Disadvantage.

This alternative could fragment some courses, since there may not be a logical dividing point. It will take more time for an individual to complete a training program, while requiring extra travel, increasing costs, and can create additional scheduling problems at the facility.

5. Combine courses at the Academy with directed study courses at the facility.

Advantage.

The team expected an improvement in morale by requiring less time away from family. Training costs will decrease from savings in per diem and reduced requirements at the Academy.

Disadvantage.

This alternative will require closer supervision at the facility for individuals in directed study courses. It will take longer for individuals to complete a training program, and the division of courses could have an adverse effect by disrupting continuity.

6. Provide all training onsite.

Advantage.

This option reduces travel costs, requires no time away from the facility, and allows technicians to be available for operations.

Disadvantage.

Equipment will not be readily available for training purposes, and there will be more distractions and less dedication to study with the loss of the classroom environment.

7. Provide contractor training at the facility.

Advantage.

This will decrease travel costs and time away from home. There are no FAA costs for course development, and technicians will be available for operations.

Disadvantage.

Overall cost could increase for contractor-provided training with less control over content and construction. The loss of the classroom environment means more distractions and less dedication to study.

Recommendation.

The Assessment Team recommends alternatives 2 and 5, with emphasis on alternative 2.

RETRAINING EMPLOYEES. That personnel of the Airway Facilities workforce that are most severely impacted by implementation of ETABS are the technicians responsible for the maintenance of the mechanical flight strip printer. These technicians normally are referred to as Peripheral Device Technicians (PDT's). Since the mechanical flight strip printer will be removed, these positions will be abolished.

Alternative.

Retrain the forty-five technicians affected by ETABS in basic electronics to become automation technicians.

Advantage.

Provide upward mobility and improve employee morale.

Disadvantage.

It is anticipated that nationally, five of these technicians will not be capable of successfully passing the training requirements for the automated system. Some PDT's have not advanced into higher grade levels in more technically complex positions due to an inability to satisfactorily complete the training requirements of complex electronic systems. A number of PDT's were formerly teletype technicians and have never had electronic experience or training in solid-state devices. It is highly possible they will be untrainable even if positions in other technical specialities do exist.

Recommendation.

It is recommended that a timely retraining and counseling plan for PDT technicians be developed and implemented in each center where PDT's are employed.

ACADEMY TRAINING QUALITY. The resources and procedures are available within the FAA to develop ETABS training. However, the results and quality of Airway Facilities automation training at the FAA Academy have declined significantly in recent years.

There could be a significant negative impact in the maintainability of ETABS as the result of the quality of training received. Automation software units within the Academy are hard pressed to get qualified personnel. The degree of concern for current training problems indicates that this downward trend may continue with ETABS. The development of adequate courses for ETABS may lag the implementation of this system.

Alternatives.

1. Establish a training lab for Airway Facilities personnel at each facility.

   Advantage.

   By establishing a training lab at each facility, the agency could realize a savings in travel and per diem costs, not only in conjunction with ETABS, but also other new programs. This lab would also foster proficiency which would create as the end result an improved mean time-to-repair.

   Disadvantage.

   The cost factor must be considered a disadvantage since the initial cost to set up a laboratory facility and the maintenance expense would also increase. Another problem is that the space required is not readily available.

2. Increased grade level of instructors with return rights to the last field grade held.

Advantage.

There should be an increased motivation for more qualified people to express an interest in instructor positions.

Disadvantage.

The cost of this type program would increase. Also, a waiver would have to be obtained and the job qualifications may not meet higher grade requirements.

3. Longer tenure in instructor assignments as an employee option.

Advantage.

With the possibility of longer tenure, the mobility factor would be reduced, and this would benefit the agency improved instructor morale. The continuity of instruction would be beneficial to those being taught. A savings would be realized through less permanent change of station moves. More qualified people would become interested in accepting positions at the Academy.

Disadvantage.

The possibility exists that there would be more, not less, instructor complacency. This was projected since there would be a greater degree of lost field currency on the part of instructors. Also, the agency's upward mobility program would be affected as these positions would be available less often.

4. Contract instructors at the Academy.

Advantage.

The agency would experience reduced development costs, and the instructors would be much more current on the system being taught.

Disadvantage.

This plan would displace the FAA instructors and would have a detrimental effect on the agency's upward mobility program. We would also have less control over course material and course quality. There would be increased costs for teachers, material, and documents.

Recommendation.

It is recommended that alternatives 1, 2, and 3 be considered.

AIR TRAFFIC CONTROL PERSONNEL. The ETABS training program for controllers will be in competition for normal ongoing training resources. At least 30 percent of the existing Center training resources will have to be allocated to ETABS training for approximately 3 months. If Air Traffic maintains the software, approximately 50 percent of the ARTCC Data System Specialist (DSS) staff must be trained in a new program. This would involve approximately 188 DSS's.

Alternatives.

1. Provide ETABS in the (DYSIM) laboratory environment with standalone capability.

Advantage.

This would be the ideal training environment since it would be under simulation conditions. This would also add to a smooth implementation of the system.

Disadvantage.

Disadvantages to this would be the cost for the hardware; however, the DYSIM will eventually require this equipment. Increased software and maintenance workload and the ongoing training programs would be adversely impacted.

2. Develop a national standardized program for ATC training.

Advantage.

This would provide standardization of a training program that lends itself to controller's acceptance. It would reduce facility workload for developing the training program.

Disadvantage.

A disadvantage to this would be that the program would not compensate for local facility problems.

Recommendation.

Both alternatives are recommended.

TRAINING EXPENDITURES. Historically, training requirements are the first to be cut from budget items. The additional ETABS training requirements for technicians, software staff, and computer operators could suffer if this is continued. If adequate budgetary provisions are not provided for training, all ETABS technicians will be impacted.

Alternative.

1. Funds should be provided for factory training and instructors for onsite training.

Advantage.

a. Improved operational availability of the system.
b. Improved mean time between repair.
c. No delay in initial system commissioning.

Disadvantage.

Additional monies for training expenditures.

Recommendation.

Alternative 1 is recommended.

LOGISTICS SUPPORT

AREA OF CONSIDERATION.

No system, regardless of its technological level, will remain reliable without adequate logistics support. This section addresses conditions which may be encountered in logistics areas. A staging area during installation, system certification program, test equipment and diagnostic programs, test spare parts and printed circuit board maintenance procedures are all seen as areas of concern in the support of ETABS.

IMPACT FACTORS.

1. System Certification.

It is a requirement to perform periodic certification on ETABS. This would include situations when accidents or incidents have occurred. However, this is a normal procedure to insure the operational acceptability of the system.

If the capability to verify all critical functions and parameters with an on-line program is not delivered with the initial system, certification will have to be done manually off-line. These two modes of certification are compared as follows.

Alternatives.

1. Provide on-line certification capabilities.

   Advantage.

   An on-line system meets certification requirements, increases efficiency and availability, aids in troubleshooting, and is always available as a test capability.

   Disadvantage.

   The initial cost of providing an on-line certification function for ETABS is a disadvantage.

2. Provide an off-line certification system.

   Advantage.

   There is an initial cost savings over an on-line system.

   Disadvantage.

   This method is estimated to cost 15 hours per week at each site. Further, this would necessitate the on-line function to be added

at a later date at a minimum cost of 300,000 dollars. There is also decreased efficiency and availability over an on-line system.

Recommendation.

We strongly recommend that the capability for an on-line system certification be part of the initial ETABS program.

SPECIAL TESTING DIAGNOSTICS. The identification and procurement of the type and number of any special test equipment, maintenance diagnostic programs, and test stations was judged to be a requirement. Further, if no on-line diagnostic programs are available that can identify sector interface and system problems, conditions could be created which may prove detrimental to maintainability and reliability. This impact can be increased if the documentation describing the ETABS/Central Computer Complex interface is inadequate.

Alternatives.

1. Provide off-line diagnostics for element and thread testing.

   Advantage.

   This minimum requirement aids in troubleshooting.

   Disadvantage.

   None.

2. Provide on-line diagnostics for element and thread testing.

   Advantage.

   An excellent troubleshooting aid that will increase system availability.

   Disadvantage.

   None.

Recommendation.

Both alternatives are recommended with the off-line system supplemental to the on-line program.

TEST EQUIPMENT. We must address the continued problem of buying printed circuit board testers with each system. History shows that these testers are never efficient and their desirability is questionable.

Alternatives.

1. Delete the requirement of circuit board testers for ETABS.

Advantage.

a. They are not effectively used.
b. A system savings of 400,000 dollars will result.

Disadvantage.

None.

2. Use a single universal programable card tester for all logic cards within the facility. Such a tester could be the John Fluke Model 3020A, which many manufacturers use in production testing.

Advantage.

The unit is presently available at some sites in conjunction with AWANS.

Disadvantage.

Setup time and training costs are disadvantages.

Recommendation.

We recommend both alternatives for adoption.

SPARE PARTS. Adequate and timely logistics support to supply spare printed circuit boards and other components is critical to the success of the ETABS program. A special problem is identified if multilayer printed circuit boards, which are complex and expensive, are used in ETABS. These units are not field repairable and can create a logistics problem in depot repair turnaround time and added investment in site spare parts inventory to insure system reliability. The cost of repairing printed circuit boards and the lack of circuit test equipment has caused problems in current automation systems.

Alternatives.

1. Explore the possibility of plug-in components; i.e., integrated circuits and transitors.

Advantage.

Ease of maintenance, cost savings in manpower and system availability.

Disadvantage.

Possibly a slight increase in manufacturing cost.

2. Spare parts, circuit boards, documentation updates, and other components be made available onsite in adequate number.

Advantage.

The advantage to be gained through this recommendation will be a decrease in the mean time-to-repair and an increase in system reliability.

Disadvantage.

The requirement at each site to define and allocate additional storage areas for spare parts.

Recommendation.

Both alternatives are recommended.

SURPLUS EQUIPMENT AND STORAGE. A valuable lesson was learned at many sites during the installation of NAS Stage A when equipment was delivered without adequate storage space. It became apparent that a secure staging area was required to store this equipment before and during installation. This problem will reoccur with ETABS.

Arrangements are needed for the timely disposition of surplus equipment to prevent extended storage requirements. Approximately 5,000 square feet of space must be available for ETABS equipment and existing surplus equipment. If this space is not provided on a timely basis, problems could develop with contractual delays, implementation delays, and increased clutter in the Center buildings, thereby, resulting in increased installation costs.

Alternatives.

1. Provide a staggered schedule of delivery to each site.

   Advantage.

   This solves the problem of incoming equipment and reduces the amount of storage required.

   Disadvantage.

   This does not take into consideration the disposition of surplus.

2. Determine and provide, as needed, locally-leased storage space.

   Advantage.

   This solves the problem of incoming equipment, retains flexibility, and reduces the amount of storage space required.

Disadvantage.

Increases installation costs.

Recommendation.

Alternative 2 is recommended.

CONCLUSION

In the assessment of ETABS, hundreds of impacts were examined. This number was reduced to thirty-eight, through a process of data collection, sizing, and analysis. Following this, alternative generation and recommendation-making followed. Thirty-three items were considered sufficiently important to deserve corrective action, while five have positive impacts requiring no action.

Figure 1 shows the team's evaluation of the effect of ETABS implementation, if the recommendations are or are not provided for.

A -- NO RECOMMENDATIONS IMPLEMENTED.

B --THE THREE CRITICAL RECOMMENDATIONS IMPLEMENTED.

C --ALL RECOMMENDATIONS IMPLEMENTED.

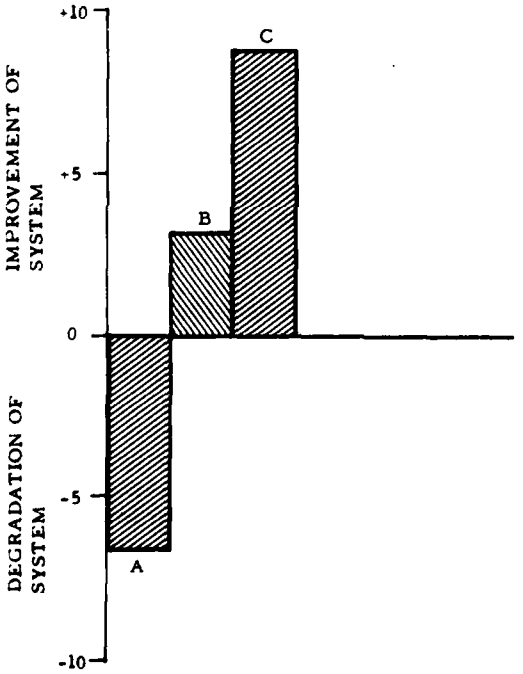


FIGURE 1. FIELD VIEW OF ETABS

Figure 1 also shows the team's evaluation of the effects of implementing or not implementing the ETABS recommendations cited in this report.

It is the team's strong feeling that three specific impacts are critical and must be resolved prior to start of implementation. Action should be taken to assure that early in the system design program these items are provided for. If they are not resolved, implementation of ETABS should not proceed.

The three critical impact items are discussed in the following paragraphs.

Backup/Redundancy for ETABS. A major concern with the ETABS system is the possibility of failures ranging from one sector through a combination of IBM 9020/ETABS. The variety of failures were considered and recommendations made to cope with them. Included are provisions for data relocation, data freeze, IBM 9020 flight data printout, and off-line miniprocessors.

The importance of this impact item cannot be overemphasized; it is the heart of the success of this project. If a realiable backup system is not provided, air traffic safety could be compromised.

Installation and Cutover Process. This transition activity must be carefully planned for minimal interference with the ongoing ATC operation. Noise, distractions, relocation of people, and functions on the operations floor could otherwise create an environment leading to system errors.

Three recommendations are made, which will provide for a safer and more effective transition process.

The first recommendation requires an ETABS dynamic simulation function position. This will provide for advance training, equipment checkout, and will reduce test time on the operations floor.

The second recommendation provides NAS software that will allow the addition or deletion of any number of operational sectors. This will facilitate the relocation of controllers and functions as the cutover process progresses.

The third recommendation provides for modular installation. This is a system design using individual sector equipment group components, which can be installed individually with minimum interference to the existing interphone, radio, control, and power wiring.

Dual System Operation. The NAS program must support both the ETABS and the Flight Strip Printer/Computer Update Equipment systems simultaneously during the shakedown and cutover period. This will allow development of a level of confidence, provide a backup mode, and allow for a comparison of accuracy.

To accommodate this program, additional computer storage resources will be necessary in the IBM 9020.

Although special emphasis has been given to the critical items, the relative importance of the remaining factors must not be minimized. Even after arrangements have been made to correct the three critical issues, all of the normal agency support for orderly implementation of a major program must be accomplished to resolve the remaining elements.